A study on genetic diversity of Egyptian native livestock

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CONTENTS

Chapter 1. General introduction

Conservation of genetic diversity is one of the main current issues in the conservation biology literature. Conservation is not only about endangered breeds but also about those that are not being utilised efficiently. Conservation of all poultry breeds is considered to be financially infeasible so that priorities need to be set on which population/breed is to be conserved. Both genetic diversity and non-genetic criteria are important for prioritizing breeds for conservation. The non-genetic criteria include threat status and breed merit. Egyptian local poultry breeds are characterized by high marketing prices owing to the lovely good flavor of their meat and eggs. They are highly adapted to harsh environmental conditions and thought to constitute genetic reservoirs. The highly productive commercial poultry breeds have replaced local ones across the world. This development has led to growing concerns about the erosion of genetic resources. Information of poultry genetic resources is considered a useful model for studying conservation of genetic diversity in wild animal species. Therefore in this study, I evaluated the genetic diversity of Egyptian chickens and pigeons in order to apply this information for conservation purpose by using two different strategies. The first strategy (in chapter 2) was maximization of genetic diversity based on neutral microsatellites genetic markers while the second strategy (in chapter 3) was genetic improvement by low selective pressure based on functional gene polymorphisms. For the first strategy, I evaluated the genetic diversity and the breed contribution to aggregate genetic diversity (contributions to the between-breed and to the within-breed diversity components) as important criteria for their conservation by utilising three different prioritization methods in order to set the priorities for conservation of Egyptian chickens and pigeons. The three methods used for evaluation of the breed contribution to aggregate genetic diversity were *D1* = (Ollivier and Foulley, 2005) & *D2* = (Petit et al., 1998) and *GD* = (Caballero and Toro, 2002) methods. For the second strategy, the polymorphisms of Lactate dehydrogenase-*A* (*LDH-A*) gene might be used as genetic marker for selection of high performance pigeons, and it might be useful for conservation and sustainable utilisation through improvement of local population's performance. Also for wildlife, basic understanding of *LDH-A* genotype and homing ability might be useful for studying of wild migrating birds.

Chapter 2. Genetic diversity and its application for conservation priority of Egyptian poultry

2.1. Evaluation of genetic diversity and conservation priorities for Egyptian chickens

I surveyed 196 samples derived from six Egyptian chicken populations (Fayoumi, Dandarawy, Baladi, Sinai, El-Salam and Golden Montazah) in addition to 42 samples from White Leghorn and 43 samples from Rhode Island Red chicken breeds by using 21microsatellite markers. Based on the genotyping, the six studied Egyptian populations showed a moderate level for both within-population (MN_A = 4.9; H_E = 0.595) and between-population (F_{ST} = 0.082) genetic diversity and were clustered into four clusters by STRUCTURE. Fayoumi, Dandarawy and El-Salam populations were assigned independently into their respective clusters while the remaining three populations (Baladi, Sinai and Golden Montazah) were clustered together forming admixed mosaic cluster. Regarding the breed contribution to aggregate genetic diversity, Dandarawy breed contributed the most according to Petit et al & Caballero and Toro methods (*D2*= 2.49, *GD*= -1.40) and ranked the first, while Fayoumi breed contributed negatively to aggregate genetic diversity and ranked the last according to the three methods (*D1*= -1.15, *D2*= -1.89 and *GD*= 1.72).

2.2. Evaluation of genetic diversity and conservation priorities for Egyptian pigeons

Pigeons are bred for many purposes like meat in the form of squabs, exhibition as fancy and ornamental, flying sports like racing competition and finally for laboratory experiments of cognitive sciences. Domestic pigeons were promoted by Darwin as a proxy for understanding natural selection in wild populations and species. Domestic pigeons and wild bird species vary in many of the same traits, so domestic pigeons provide an entry point to the genetic basis of avian evolutionary diversity in general. On the contrary, feral pigeons can cause some ecological and public health problems.

I surveyed 110 samples derived from six Egyptian pigeon populations (Krezly, Zagel, Safi, Asfer Weraq, Ablaq and Romani) in addition to 23 samples from Japanese racing pigeons by using 11microsatellites markers. Based on genotyping, the six studied Egyptian populations showed moderate within-population (MN_A = 4.10; H_E = 0.580) and high between-population (F_{ST} = 0.211) genetic diversity. The Egyptian in addition to Japanese racing pigeon populations were clustered into six clusters. Krezly, Safi, Romani, Ablaq and Japanese racing populations were assigned independently into their respective clusters while Asfer Weraq appeared as a mixture from Safi and Ablaq breeds and finally Zagel breed appeared as a mosaic with Japanese racing population. Regarding the breed contribution to aggregate genetic diversity, Zagel breed contributed the most according to Ollivier and Foulley & Caballero and Toro methods (*D1*= 8.169, *GD*= -4.260) and ranked the first, while Asfer Weraq ranked the last according to the three methods (*D1*= -0.257, *D2*= -2.741 and *GD*= 1.439). Zagel has wide genetic base because of its wide distribution and so it contributed the most to aggregate genetic diversity while Asfer Weraq contributed the least because of the bottleneck effect.

Chapter 3. DNA polymorphism within *LDH-A* gene in pigeon (*Columba livia*)

The homing pigeon is a variety of domestic pigeon derived from the wild Rock Pigeon (*Columba livia domestica*) selectively bred to find its way home over extremely long distance. Lactate dehydrogenase gene family is involved in aerobic and anaerobic metabolism; therefore it determines muscle endurance, recovery and aerobic capacity. A total of 221 (123+36 for Japanese and 31+31for Egyptian) samples of two different groups of pigeons were genotyped; 123 samples of Japanese racing pigeons representing Japanese homing group and 36 samples of free living wild rock dove, for simplicity termed non-homing group. Thirty-one samples were collected from nine Egyptian local breeds bred mainly for flying game and racing purposes representing Egyptian homing group. Another Thirty-one samples were collected from three Egyptian local breeds bred for ornamental and fancy purposes representing non-homing group. I found six polymorphic sites (one indel and five SNPs) in *LDH-A* gene intron 5. High statistical significant differences in allele and genotype frequencies were observed in four (Indel, T182C, G249A, T297G) out of the six loci between Japanese homing and non-homing pigeons, whereas only one locus (Indel; ID5) showed significant differences in allele and genotype frequencies between Egyptian homing and non-homing pigeons. For the indel polymorphism, I found that the long allele (600bp) showed significantly higher frequencies than short one (595bp) in the homing than non-homing in both Japanese and Egyptian pigeons and it might be used as genetic marker for conservation and sustainable utilisation through improvement of local population's performance.

Chapter 4. General discussion and final remarks

In this thesis, I evaluated the genetic diversity of Egyptian chickens and pigeons in order to apply this information for conservation purpose by using two different strategies. The first strategy (in chapter 2) was; maximization of genetic diversity based on neutral microsatellites genetic markers, while the second strategy (in chapter 3) was; genetic improvement by low selective pressure based on functional gene polymorphisms. In this thesis, I used neutral genetic marker information as a first step for prioritization of the local breeds for conservation. As a next step, I need to consider the non-genetic criteria like threat status and breed merit of Egyptian local poultry breeds in the prioritization procedure. For the second strategy, I used one example of pigeons functional gene diversity (*LDH-A*) which might be useful for conservation and sustainable utilisation through improvement of local population's performance. Also for wildlife, this result might be useful for basic understanding of *LDH-A* genotype and flying and homing abilities in wild migrating birds.

In conclusion, consideration of neutral genetic diversity and functional genes diversity in addition to breed merits and threat status, enabled us to balance the trade-offs between conserving genetic diversity as insurance against future uncertainties and current sustainable utilisation.